

FRONTAL LOBE WOUNDS CAUSING DISINHIBITION

A STUDY OF SIX CASES

BY

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The study of disturbed function following injury or surgical intervention has yielded a large amount of information about the effects of such injury when it involves the frontal lobes in man, and certain patterns of reaction have become apparent after frontal lobe damage. The significance of these patterns as indicators of the part played by the frontal lobes in the general organization of thought and behaviour is, however, less assured, and their relation to anatomical site within the pre-frontal area is still a matter of conjecture.

The type of change which appears from case to case shows much inconstancy, although cases can always be identified which show a similar constellation of symptoms. Of these changes the most impressive are those in which character and temperament are profoundly altered. Thus, the self-respecting man becomes irreverent or inconsiderate of the feelings of others; uninhibited behaviour becomes apparent and may be of a degree to bring the individual into conflict with society and its laws. These striking changes in personality, which were first adequately described a hundred years ago by Harlow (1848, 1868) in the classic case of Phineas Gage, are rare but are of such a distinctive qualitative nature that they form perhaps the most characteristic feature of the "frontal lobe syndrome". They can all on the whole be regarded as due to "disinhibition", that is to say, to a disturbance of the mechanisms responsible for the control of behaviour in its social setting.

When we come to study the phenomenon of disinhibition after frontal lobe injury two points of great significance emerge. First, changes in character and temperament due to disinhibition seem only to occur significantly in a minority of cases, and it is not generally possible to establish disinhibition in every case of frontal lobe damage. It may well be,

however, that subtle changes in this direction not easy of assessment do occur in many more cases.

Secondly, when disinhibition is present the degree to which it occurs varies widely. This is because the disinhibition involves different aspects of the personality in different people, so that the aspects of the personality affected may have a variable social significance, making the new behaviour more or less offensive when taken within the context of the special fields of social control involved.

In so far as the frontal lobes are concerned with inhibition, no understanding of their functional role in this respect will be complete unless answers can be given to these two questions, Why does disinhibition seem only to occur significantly in a minority of cases? And why, when it does occur, does it involve different aspects of the personality in different people?

In the present paper six cases are described in which clear evidence of disinhibition was found following wounds involving the frontal lobes. They are taken from a group of 43 penetrating brain wounds in all sites which have been studied personally and in which changes in behaviour and intellect have been investigated. The majority of the 43 cases had frontal lobe involvement. They form a part of a series of approximately 900 penetrating brain wounds in Service personnel from the last war and from Korea whose records are preserved in the Head Injury Bureau attached to the Military Hospital for Head Injuries.

Method of Investigation

Personality Studies.—In investigating changes in behaviour special attention has been given to pre-traumatic personality studies, and all available sources of information have been followed up, including interviews with relatives, reports from probation officers, visits by psychiatric social workers, and scrutiny of Army documents.

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Intellectual Changes.—The estimation of intellectual changes after brain injury presents special problems, as various types of impairment in intellectual functioning may occur.

In the present study the deficits in intelligence which have been investigated are deficits in conceptual activity. Intelligence is thus used in the sense in which it is defined by Wolf (1947) as the "mental function of apprehending connexions", and it is the preservation or loss of this ability which has been especially studied.

Method of Estimating Deficits.—Information with regard to pre-traumatic intelligence is often scanty. Some information can usually be obtained from the scholastic and occupational record of the patient, but this is often unreliable.

Most methods devised to demonstrate intellectual impairment in organic cases are based on groups of tests, some of which show respectively some resistance or vulnerability to trauma. Thus, when a patient with traumatic deterioration is not dysphasic, his ability to reproduce vocabulary is usually preserved, and this is widely used as an indication of his pre-traumatic intelligence level, because it is generally true that the higher an individual's vocabulary (i.e., the greater the number of words he knows) the higher is his intelligence in the conceptual sense. Provided certain limitations are recognized, this method should yield valuable results, and the tests used in this study are based on this principle. The tests are well known, but they have been re-standardized for the purpose of this investigation against a group of normal controls. They are the 1938 Raven Progressive Matrices, the Hartford Retreat Vocabulary (H.R.V.), and the Hartford Retreat Test (H.R.T.). These tests have been administered to the normal controls to estimate what levels of vocabulary on the H.R.V. are equivalent to what point scores on the matrices and on the H.R.T., the maximum score in each being: H.R.V., 40; on the matrices, 60; and the H.R.T., 20.

Control Tests.—The controls used were 50 soldiers aged 18 to 35 (median age 19) who were thus in approximately the same age-group as the men who had sustained the penetrating brain wounds. They were a sample of soldiers admitted to the general wards of the Military Hospital for Head Injuries suffering from medical and surgical conditions, the only criterion in their selection being that cases with brain damage and psychoneurosis were excluded.

The results have been plotted on Fig. 1 and the

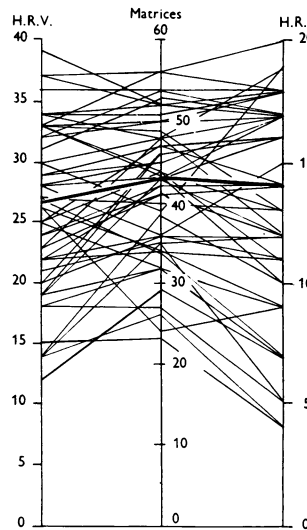


FIG. 1.—Chart showing distribution of test scores in 50 normal controls. The thick line represents the position of the median score on each test.

median score on each test for the whole group has been superimposed as a thick line. The median score on the matrices in the sample is 43, while Raven's median score for this age-group is 44, calculated from the natural scores of several thousand soldiers and civilians (Raven, 1950).

In this control group, therefore, the median score on the matrices is 43, in the H.R.V. 26.5, and in the H.R.T. 14.

The distribution of the results in these 50 normal controls

shown on the diagram demonstrates a wide scatter between the ability to reproduce vocabulary and to perform conceptual tests, especially in the lower and medium intelligence levels. It can be seen, however, that when the higher vocabulary levels are reached the results on the matrices and H.R.T. tend to equate more consistently with the vocabulary scores, as shown by the greater number of lines going almost straight across. In using such a method as this, therefore, to estimate the presence or otherwise of intellectual impairment, it is necessary to avoid drawing conclusions which are not justified in view of the range of the normal sample.

Most of the injured men were enlisted from 1942 to 1948 and were given intelligence tests as part of the personnel selection procedure, and these results are still available for some of the cases. In this personnel selection procedure the principal test used was the 1938 Raven Progressive Matrices.

In addition, cases treated at the Military Hospital for Head Injuries in 1944–45 were tested in the early stages of brain injury by the late W. R. Reynell, who used a series of tests of which the 1938 matrices was one. It has thus been possible in certain cases to demonstrate scores on the same test, i.e., the matrices, at different stages in the man's history—at Army entry, in the early stages after brain wounding, and several years after the injury when tested by the author.

In the case of men recently wounded in Korea no comparison has been possible between the matrices score before and after wounding. A comparison has, however, been possible on another test. Since 1948 the Army has used as part of its personnel selection procedure a test called the Army Dominoes. This is still a confidential test, and details of it cannot be given; it is sufficient to say, however, that it is based on the same general principles as the matrices, i.e., it is a pattern test, and is graded like the matrices in the same percentile groupings: Grade I (S.G. I) at or above the 95 percentile score for testees of his own age group (intellectually superior); Grade II (S.G. II) at or above the 75 percentile score (definitely above average); Grade III (S.G. III) between the 75 and 25 percentile scores (mentally average); Grade IV (S.G. IV) at or below the 25 percentile score (definitely below average); and Grade V (S.G. V) at or below the 5 percentile score (intellectually defective). The maximum point score on this test is 48.

In order that some visual representation may be given of the presence or otherwise of intellectual impairment as shown by these tests, a chart has been constructed (Fig. 2) on which the results in each case can be plotted. For this purpose the scores given on the H.R.V. have been divided arbitrarily into three groups, i.e., scores lying between 11 and 20, 21 and 30, and 31 to 40. The median scores in each of these three groups with the equivalent median scores on the matrices and the H.R.T. have been traced on the chart. On facsimiles of this chart the results of intelligence testing in the six brain-wounded cases have been recorded (Figs. 4, 6, 8, 10, 12, 14); the result of the Army Dominoes, where administered, has been plotted on a fourth column.

Absolute and Functional Impairment.—In all these tests, with the exception of the matrices, the subject scored his own results. The Army Dominoes test was limited to 20 minutes so as to repeat the conditions under which it was administered on Army entry, otherwise none of the tests was strictly timed.

In the case of the matrices, the author scored and the subject read out his answer to each example. This formed a valuable means of studying test performance, and patients taking an abnormally long time, experiencing difficulties, or showing carelessness in attempting the test, could be identified. In every case the aim of the testing was to see how well the patient could do, and not how badly.

Under these circumstances of testing it became

obvious that two types of impairment could be recognized. In certain cases there was an absolute impairment which was shown by the inability, even

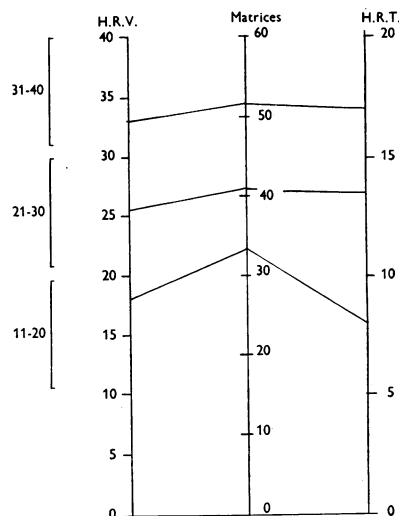


FIG. 2.—Recording chart for mental test results. The transverse lines represent the position of the median score on each test in the 50 normal controls in three vocabulary ranges of the H.R.V. test. These control lines appear as a background on subsequent charts on which the results of mental testing in the brain wounded cases are recorded.

when the subject was trying hard, to see through the more complex relations involved in the conceptual tests. In these cases the subject failed to reach the expected level in all the tests used with the exception of the vocabulary.

In other cases a functional impairment in test performance was noted by a careless and erratic response or in fluctuations between tests. When this was apparent on the matrices and the patient was producing a score lower than was thought justifiable, then he was given an opportunity to correct his mistakes once only, and a corrected score on the matrices was obtained. This corrected score is also shown on the recording chart in certain of the six cases.

Case Material

In the six cases now described disinhibition has occurred predominantly in sexual behaviour in three cases and in simple social behaviour in three.

Disinhibition in Sexual Behaviour.—Case 1 has already been briefly reported by Russell (1948).

Case 1 (M.R.C. No. 203).—This 19-year-old private was wounded on August 6, 1944. Sixty hours after

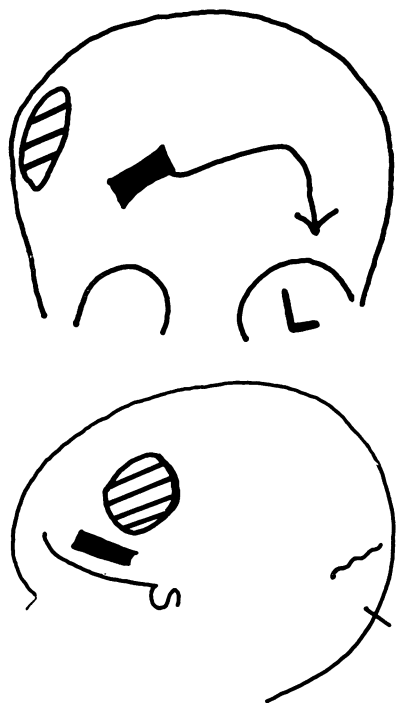


FIG. 3.—Tracings of skull radiographs in Case 1.
Metallic foreign body wandering from track
in right frontal lobe to left anterior fossa.

wounding he was conscious, drowsy, restless, and disorientated. There was a wound in the right frontal region, with a large metallic foreign body $3 \times 1 \times 1$ cm. embedded at a depth of 6 cm. downwards and forwards.

On admission to the Military Hospital for Head Injuries on August 9 he had a left hemiplegia including the face. He gave monosyllabic answers to simple questions and was quiet and drowsy. By August 15 he was fully conscious, rational, and cooperative, correctly orientated as to place and remote happenings, and gave a good account of his home, regiment, and Army career, but was disorientated for time and recent events. A radiograph taken on August 13 showed the metallic foreign body (a bullet) now lying on the floor of the left anterior fossa (Fig. 3). At operation on August 21 (Brigadier Cairns) it was removed, the dura being opened along the lateral edge of the left frontal lobe.

The course of this bullet from the depths of the wound track deep in the right frontal lobe to the subdural space of the left anterior fossa is a matter of conjecture. A radiograph taken on August 9 suggested that the bullet lay in the trigone of the right lateral ventricle, but it was the opinion of Sir Hugh Cairns that the missile was actually subdural and that it eventually reached the left

anterior fossa by passing across the subdural space on the inferior surface of the frontal lobes. This would suggest that the left frontal lobe was left intact.

After operation the patient's course was uneventful, and by August 23 he was conscious but lacking in initiative and frequently incontinent of urine. By September 7 he was mentally alert and rational, was still incontinent at night, and was not yet fully orientated in time. By September 19 he was fully orientated and no longer incontinent. By the time of his discharge on November 9, 1944, he appeared to have made a good physical recovery.

Early in 1947 he was put on probation after being found guilty of several minor charges of housebreaking, when his father reported as follows: "Since my son's discharge from the Army he has shown no power of concentration whatsoever. He is unable to remain still for any length of time, walking from room to room. He sleeps abnormally long hours and has an enormous appetite. He shows no interest in any hobby and never completes anything he may start. His language is obscene, and his chief conversation is about sex; this began from his first conscious moments in hospital when he said that all the nurses were prostitutes. Notwithstanding the fact that sex predominates in his mind, he has not shown any zeal or over-interest in running after girls, and I have no reason to think that I should have any worry from this."

When examined in October, 1951 (H. F. J.), he was noted to have certain stereotyped habits, yawning frequently, and when smoking a cigarette he would do so with a peculiar jerky, sucking movement. His brows were continually furrowed, and he gave the impression of being "worried". The basic charm of his personality was, however, still evident. He was of rather immature appearance.

After a latent period of a few minutes at this interview (he had not seen the examiner before), he plunged into sex talk quite spontaneously, opening the conversation with "you see, it's the sex problem". He described a recent liaison with a woman of undesirable character which was still continuing—"She is crazy about me. I don't see how any girl could be crazy about me." He admitted intercourse "once or twice". "Is it wrong?" "Why do you ask if it is wrong? Don't you know?" "Well, it's in the Bible and all that sort of thing, in the Commandments." In his talk on sexual matters he expressed many prejudices about the sex activity of people of other nationalities, especially American servicemen. His first sex experience of significance was at the age of 15, when a young girl allowed him to handle her breasts. Afterwards he was terrified, and pleaded with her not to tell her parents. He was even more terrified when she told him she was menstruating. At the age of 17, shortly before he joined the Army, a young married woman, the wife of a serviceman who was then overseas, induced him to have intercourse with her.

He admitted that since adolescence he had been addicted to reading cheap American magazines of a type describing sex play. He described a phenomenon of

considerable interest, namely, an aversion to seeing any socially permissible sexual activity on the part of other people. If he goes to a cinema and sees a young couple kissing, he has to get up and go out. When asked why, he stated, "I get a feeling in the pit of my stomach. I suppose I want to be doing it too."

In the analysis of his sex talk (and this will be dealt with fully later) it is obvious that it is in the nature of a protest against sexual activity in general. The American serviceman who arrived with a naked woman in the back of a taxi is "indecent", so are the pictures of scantily clad girls in certain Sunday newspapers.

He then described how difficult it was for him to be aroused to anger. The other patients attempt to do it but he tells them, "You know if I liked I could knock you all through the window." When asked why he did not, he replied, "Well, you see what they are (disabled ex-servicemen). How could I?" He also stated, "I used to be so different, so quiet, so timid; now I talk on and on."

When the patient was visited at home by an experienced psychiatric social worker (A.E.) he was well dressed and groomed. He talked incessantly about himself for an hour and a half. After a few minutes' acquaintance he plunged into shockingly uninhibited conversation, although he was seeing the lady visitor for the first time. The following is a sample:

"Yanks are beasts. Every girl in — is carrying a child by a Yank. Two of them raped a girl of 15. Sex is my dominating feature. I like sex books—*Lady Chatterley's Lover*. I've read — this and that — I wonder if Lady Chatterley ever lived, the most filthy-minded bitch—. I read Hank Janson. That's a new one on you. Always girls. In his books men are always mixed up with some woman's blouse or thighs. The price list of a little babe when it's illegitimate, 30s. a week until it's 21. I know I am a nuisance. I can't keep off sex talk."

"I read about Mother India once. What these Indians do to their women. They just put their hands into a pregnant woman and pull the baby out. And if it won't come out they stuff cow-dung into the womb. Fancy, cow-dung. The filth."

The following account was obtained from his father:

"As you have seen my son now, so he is all day long. All day he follows his mother around, he never leaves her, he never goes out except for a packet of cigarettes, he can settle to nothing, he can do nothing, he uses sex talk of the character you have heard all day. The only time he shuts up is when we have visitors, and then he will be silent for a while until he gets used to them, then it starts all over again. Before his wound he was a delightful child. He was evacuated during the war and stayed with my sister. I know he was well disciplined there; my sister would stand no nonsense. He went to private schools, as he did not get on at the primary school. He was not an intellectual type of boy, but he was average. He was not a boy interested in sex. When my boy and girl were aged 8 and 10 respectively I told them all they wanted to know. From early childhood

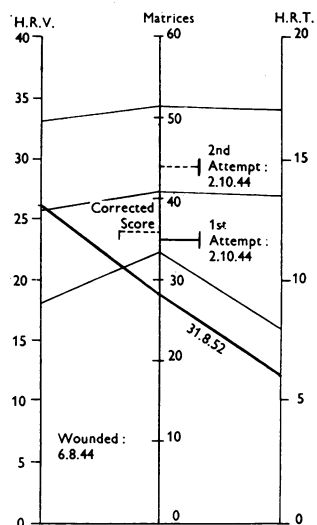


FIG. 4.—Mental test results in Case 1. No pre-traumatic scores were available in this case.

think he is jealous really of the Yanks. He has become very easily led, no regard for right or wrong. No regard for money. He has no resentment about his injury. No feelings about war. No feelings at all, I don't think."

The father added this extremely interesting and important comment: "In spite of his undiluted sex talk, he is really rather prudish. Anything on a film upsets him and he will come out if he feels it is slightly indecent. He was always rather a modest type of boy. He would not enter a bathroom where his sister might be washing or where she might be slightly unclothed."

It is difficult in this case to draw categorical conclusions about the presence of absolute intellectual loss; intellectual functioning is, however, impaired (Fig. 4). When tested by the author on August 31, 1952, the patient's basic score on the matrices was 28. He was able to correct this to 36. However, when tested on October 2, 1944, by Dr. Reynell, he produced a basic score of 35 and a score of 44 on a second attempt. This last score is within the range expected by his vocabulary level (26), and it is confirmed by the history that he was only of average intelligence and, indeed, had some difficulty in schooling. Moreover, his distractibility was such that it might well be a factor interfering with adequate test performance. No pre-traumatic scores were available in this case.

When the case is analysed certain points emerge which are important to the understanding of the changes which have taken place

First, there has been an apparently complete change in personality, in this case amounting to a reversal. A boy who has been variously described by his father as "a delightful child", "a rather

they were bathed together. Nothing hidden, nothing to be ashamed of. That was the idea. When he joined the Army and went to his first unit there were a lot of Americans there. They were mad for the girls and had the money to get them. My boy didn't. He got mad at the Americans then. It is my opinion that when he had the injury the Americans were uppermost in his mind, and they stayed there, only a hundred times more so, the feeling he had about them. He never seemed to take much notice of girls before then, either at school or work. I

modest type of boy ", " not a boy interested in sex ", and by the patient himself as " so quiet, so timid ", has become garrulous and immodest, continually talking about sex. Yet when this sex talk is analysed it can be seen that it is not primarily lascivious, but is in the nature of a protest against sexual activity. As far as physical sex activity is concerned, although there have been incidents before and after wounding, there is no gross loss of control ; but concealment and judgment are lacking in his personal relations. There has, however, never been any question of indecent behaviour in public (apart, perhaps, from talk) nor of sexual crime.

The sex talk is, of course, not the only change which has been noted. He has become restless and distractable, facile and easily led. There is a marked restriction in the normal flow of thought which becomes readily dominated by his sex ideas. The appearance of these sex ideas is, however, the most prominent change. It would be entirely illogical to assume that the brain injury is responsible for their implantation ; it has, however, revealed them.

In the study of this case there is good evidence of preoccupation with sexual matters before wounding, and he was addicted to reading books of a sex type before injury. What seems to have happened is that the existence of a conflict, previously adequately inhibited and concealed, has now been revealed.

In psychopathological terms, strong tendencies towards sex expression had been partially sublimated in phantasy and in reading books of a sexual type, with occasional active sex expression, the whole being repressed to such a degree that it gave rise in the personality to a reaction formation in which he appeared externally modest, not interested in sex, rather prudish, quiet, and timid. The external appearance of such a personality bears, of course, no relation to the strength of the impulse life underneath.

In physiological terms, because of strong tendencies, strong inhibition was necessary to keep them under control ; thus, he appeared to be over-inhibited. Nevertheless, the inhibition is successful even after injury in that the more primitive aspects of sex behaviour still remain largely inhibited, but sexual talk becomes prominent. This represents the coming to the surface through disinhibition of a conflict present at the time of injury, the expression of which required under normal circumstances continued inhibition.

Even now much excitement can be induced by his witnessing the simplest manifestations of normal sex activity. Nor is control entirely absent as far as his sex talk is concerned : the latent period before he begins talking in this way with strangers is very

short indeed, but he does not begin immediately in these circumstances.

Case 2 (M.R.C. No. 188).—This 24-year-old corporal was wounded on August 4, 1944. The metallic foreign body entered the left frontal parasagittal region about 1.5 to 2 cm. to the left of the midline and 5 cm. above the supra-orbital margin, crossed the midline, and lodged in the floor of the right orbit, severely damaging the right eye, which eventually required enucleation.

At operation on August 6 (Lt. A. N. Guthkelch) the bone defect in the left frontal region was enlarged to 3×4 cm. and the dural tear enlarged to the limits of the defect. The cavity in the left frontal lobe was sucked out and the falx was seen to be torn. A cavity in the right frontal lobe was also sucked out. Five bone chips were removed. An x-ray examination on August 9 showed an operative defect in the upper part of the left frontal bone, 3.5 cm. in diameter, extending almost to the midline. From this defect three bone fragments were driven into the midline, the lower to lie just above the genu of the corpus callosum (Fig. 5).

An air encephalogram carried out on September 28 showed the upper and central part of the frontal lobe to be occupied by a series of large porencephalic cysts on the right side, extending to the tip of the frontal pole.

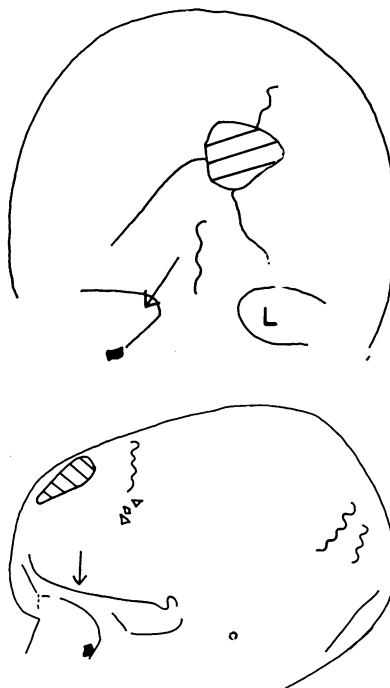


FIG. 5.—Tracings of skull radiographs in Case 2. A metal fragment entered by the left frontal parasagittal region and lodged in the floor of right orbit. Bone chips in left frontal lobe just above the corpus callosum.

The right lateral ventricle was filled and its outline was within normal limits. In none of the pictures did there appear to be any filling of the left frontal horn.

A further radiograph on November 2 showed that the multiple porencephalic cysts on the right had coalesced to form a large aerocele which communicated with the ventricular system.

An air encephalogram on December 7 showed air in the right lateral ventricle only. This communicated anteriorly with a large cerebral cyst which lay above and anterior to the frontal horn. The body of the ventricle was normal in position, with no evidence of shift.

When admitted to the Military Hospital for Head Injuries on August 7 he could give no history of his wound and could not remember going to France. He knew he was in hospital in Oxford, his name, age, and the year, but said the month was November. He was drowsy and slightly irritable. The right eye was exophthalmic, with periosteal haematoma; power was equal and good in the arms, and he was able to move both legs.

The next day he was restless and kept pulling the dressing off his head. By August 10 he was less drowsy, but now thought that he was in France. He knew the month and the year and said he felt better. By August 14 he lay still in bed with his eyes closed and was very drowsy and apathetic. When roused he cooperated fairly well for a minute or so and then relapsed.

By September 5 he was still drowsy but cooperative on examination.

His memory for events before the injury had come back to a point shortly before he was hit, and the post-traumatic amnesia was about a week in duration. He answered questions quickly and intelligently but did not volunteer information. He gave the impression of being a tired, bored man.

On September 11 he was reported to have been drowsier during the preceding three days and lay in bed sleeping. He answered reasonably when questioned, but slowly and after hesitation. Two days before he had sat for an hour with a thermometer in his mouth, owing to an oversight on the part of the nursing staff, and had made no objection.

By October 5 he was still wetting his bed at times. He answered quickly and intelligently to questioning and cooperated fully on examination, but with an air of bored unconcern during the procedure. He had some weakness of hand grip and wrist movements on the left, but there were no other abnormal signs.

By October 28 he was getting up again and there was no further incontinence of urine. He developed a C.S.F. rhinorrhoea, and on November 7 had an operation performed for dural repair (Major Calvert), at which fascial grafting of a large hole in the dura over the posterior wall of the right frontal sinus and a second large hole over the left frontal sinus was carried out. A scar in the left frontal lobe containing two bone chips and possibly a third was excised from the point of entry through the cortex down through the remnants of the falx to the cystic area in the right frontal lobe.

The following extract from Major Calvert's operation notes is given in detail so that an accurate picture may be obtained of the amount of frontal lobe tissue destroyed in this case:

"A transverse incision was made in the dura over the right frontal lobe. The frontal pole was found herniating down through a hole in the dura and the cranial wall of the right frontal sinus and anterior ethmoids. The brain was here cut through at the base of the protrusion, leaving the herniated portion *in situ*. The right frontal lobe was occupied by a large cyst, communicating with the right ventricle. This was opened, with the escape of a large quantity of C.S.F. It was found that the cyst extended to the midline and was adherent to the left frontal lobe through a large defect in the falx. The hole in the dura on the right side measured 1.5×1.25 cm.

"A similar transverse incision was now made over the left frontal pole. There was a hole in the dura over a hole of similar size in the posterior wall of the left frontal sinus through which brain was herniating. The protruding brain was cut off at its base, leaving the herniated portion *in situ*. The left frontal scar was dissected out from the cortex level down through the left frontal lobe to the wall of the cyst in the right frontal lobe and to, but not into, the anterior horn of the left ventricle posteriorly."

His progress during the next three weeks was stormy, with fluctuating temperature and increased clumsiness of the left hand. He had periods of drowsiness, when he became irrational and disorientated, and incontinence reappeared.

On January 3, 1945, he had an epileptic attack, and by then his general condition was improving. During the morning he lay in bed, sleeping or doing nothing, but got up in the afternoons. His wife stated that he tired quickly in conversation and after a short time would make nonsensical remarks; she regarded his mental state as greatly improved as compared with two weeks previously.

He was invalided home in February, 1945, and no further information apart from a routine report was obtained until 1951, when his wife complained of the behaviour which she had had to put up with during the last six years: the patient showed no control of sex, was irritable, and ill-treated her and the children.

"I hardly know quite when my husband is telling me the truth. He will do things and deny any knowledge of them. He argues over trifles and one day struck our son, aged 6, hitting him so hard on the side of the head that I feared the child might become ill. Perhaps the most trying part has been his attitude to sex. He is not content with having intercourse once but will try to go on all night and has said on occasions that he would like to treat me as a woman of the streets and rape me. His employer came to see me to tell me he was so difficult and rude to people at his work. He indulges in petty pilfering, bringing home such things as toilet paper, bottles of ink, labels, and string. He says he must be sadistic, as he likes to see me upset. He seems to have no initiative and has to be helped along all the time."

The wife gave the following account of the patient's background and pre-injury personality :

"His father is a very quiet man while his mother is possessive. He was not allowed to make any noise in the home. The clothing he was forced to wear was often the subject of laughter at school. He had a temper, but could control it. His disposition was quiet and rather reserved. He mixed quite well with people once he knew them. He was absolutely honest, and fond of children. He seemed rather under his mother's domination. He was not fond of games. He enjoyed Army life. He was always ready and willing to go to work. In his sex life he was normal and considerate."

When examined in January, 1952 (H. F. J.), the patient made little attempt to deny the facts as described by his wife. He admitted his wife complained of his excessive sexual desire and thought it was true that his sex feeling had increased since injury. He admitted it was more difficult for him to control himself in this and other ways, such as in his hasty temper. Before wounding he was rather reticent and tended to keep out of things. Now he is inclined to talk about himself, and if he hears other people boasting, for example, about their war experiences, he has to go one better. Hastier in temper, he loses control over stupid things ; he has a feeling of inferiority towards his wife, who, he states, is of a superior class to himself. He has always had a sense of inferiority and used to be ashamed at school because his mother made him wear long drawers and the other boys laughed at him when he stripped for games. The home was pretty strict when he was a child, with mother "ruling the roost". "Mother made the decisions ; father was a quiet man. Mother was quick-tempered and dominant. Sex was taboo ; its existence was ignored."

The patient stated that he had been talking more since the wound. "I must talk about myself and boast of what I have done. Normally I would be inclined to keep it all to myself. My wife complains I don't wash, and it takes me all my time to get up. My reactions are slow."

"Even now I am afraid of anyone in authority and am reluctant to ask for a private interview. I get panicky when I have to see a doctor. I couldn't care less about most things, yet when I have to see a doctor I get scared and shaky all over. Now I am inclined to brag ; before I was a quiet little boy, I didn't dare say anything. I was under the rule of my mother's stronger personality. I have less conscience now. I no longer have the ability to worry or care. The finer edges of my perceptions have been blunted. I have become less honest. If I see cigarettes lying about I will take them from the other chaps. Before, I wouldn't have done that. I am carefree about money now. Before, I was a bit of a tight-wad ; now I am more extravagant. At school I used to be frightened of games. I was frightened of the other boys and even of the girls."

Physically he is well and free from occasional attacks of traumatic epilepsy for over four years.

The following additional information was obtained from a home visit (A. E.).

"The wife stated that he was always sexually demanding even before injury but that his demands have now intensified. Instead of coming home from work he goes to the local public houses and discusses her and his relations with her in public. He masturbates openly in front of her and keeps saying he should have a love affair with someone of 17. The father was a quiet, pleasant, controlled, stable person. The mother, who was an emotional, maternal type of woman, wept readily at interview. They stated that the patient was a 'model boy'—'so good you would never notice him. Quiet, orderly, we hardly had to correct him at all'. Now he is garrulous where he had been quiet, boastful where he had been modest. The mother thinks that the talk and boasting is a cover for the feeling of inferiority which she says still lies behind it all

The boy appeared to have had a normal upbringing for his station, and sex was never discussed in the home. The mother admitted that her son had basically changed but discounts to some extent the history of his sexual behaviour, about which of course she can have no real knowledge apart from what he tells her. Both parents are aware that he might take to drink and are aware that he has begun to frequent public houses, unlike his normal habit. He is boastful about the future, but they think it is only talk."

In spite of the severe destruction of frontal lobe tissue there is very little in the way of intellectual impairment, if any at all (Fig. 6). When tested in the early stages of his injury on September 6, 1944 (W. R. Reynell), he was reported to be a "man of superior intelligence, showing little evidence of impairment". The matrices were not done at this time. On January 9, 1945, when recovering from his severe set-back, he produced a point score of 31 on the matrices. This score is an indication of his poor intellectual functioning at this stage in his recovery. When tested on February 19,

1952, by the author he was able to produce a score of 51 on the matrices and 17 on the H.R.T. These scores were within the expected range for the vocabulary level reached (38). The only information about his pre-traumatic mental testing which could be obtained from his Army documents was that he was graded as S.G. I. The actual score on the matrices was not given, but the information available would indicate that it was in the region of 55 plus, which is rather higher than his latest score. The overall selection grade

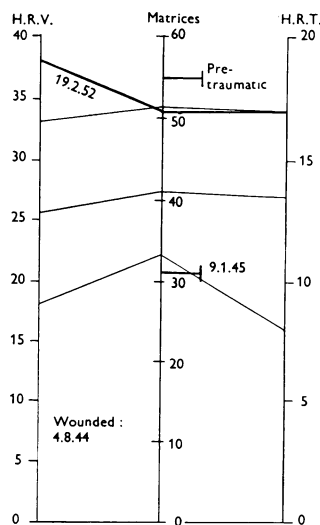


FIG. 6.—Mental test results in Case 2.

(S.G.) was probably assessed on other tests as well as the matrices, of which a vocabulary test would be one. It is a reasonable conclusion, therefore, allowing for this and for some slight deterioration in performance due to ageing, that he is functioning at much the same level as before injury.

This case shows many similarities to the previous one. A man regarded by his parents as a "model boy", "so good you would hardly notice him", has become garrulous and boastful, indulging in petty pilfering. As in the previous case, the patient himself is aware of the change in his personality. "I used to be reticent and keep out of things. Now if I hear people boasting I have to go one better. Before, I was a quiet little boy, I didn't dare say anything. I was frightened of the other boys, and even of the girls."

As in Case 1, aspects of the inhibitory process are still apparent, because, as he says, he still becomes panic-stricken when faced with anyone in authority.

His sexual behaviour has become uncontrolled. It should be noted, however, that there is no evidence of promiscuity. The nature of his pre-wounding sexual behaviour is equivocal, as his wife gives two versions, saying that he was previously considerate and at another time that he was always sexually demanding but that this has intensified since injury. She also produced evidence that his temper was uncertain before injury but he could control it. Thus, in this case also, under the cover of an externally over-inhibited personality, there is evidence of tendencies being present before wounding in the direction of the disinhibited behaviour.

Case 3 (M.R.C. No. 621).—This 25-year-old sergeant was wounded on February 19, 1945, the metallic foreign body entering through the left orbit, disorganizing the left eye, one fragment being retained in the ethmoidal cells of the same side and one crossing the midline to lodge in the right parietal lobe (Fig. 7).

On admission to a casualty clearing station on the same day he was drowsy but conscious, with loss of motor power in the left arm and leg. When injured he was knocked down but remained partly conscious. Position sense was lost in the left arm and leg, and there was decreased appreciation of pin-prick on the left side.

On admission to the Military Hospital for Head Injuries on February 21, 1945, he was conscious and orientated. He remembered being wounded and a field dressing being applied, and then no more for about 36 hours.

A radiograph was reported on as follows: "The bullet lying in the right parietal region appears to have passed through the floor of the left antrum, then through the floor of the medial wall of the left orbit close to the cribriform plate and opening the posterior wall of the frontal sinus."



FIG. 7.—Tracings of skull radiographs in Case 3. A metal fragment entered the left orbit and lodged in the right anterior parietal region.

By March 1 the left hemiparesis was noted to have improved, but was still marked in the face. By March 14 he was sitting up in a chair and walking a few steps. Mentally, he was reported bright, with a dry sense of humour. On examination there was bilateral anosmia, diminished power in the left arm, and a left facial paresis of the upper motor neuron type. No sensory loss could be demonstrated.

On March 13 a fascial repair of the dura was undertaken (Major Calvert). A large hole was found in the dura and the underlying bone, corresponding to the roof of the orbital extension of the left frontal sinus and the roof of all of the left ethmoids, and extending posteriorly slightly over to the right of the midline to implicate the roof of the right posterior ethmoids. The orbital surface of the left frontal lobe was herniating down through the defect in the floor of the left anterior fossa. The herniating brain was cut through flush with the floor of the anterior fossa leaving the herniating portion *in situ* still filling the hole. The tear in the dura measured 3 cm. \times 1½.

By April 4 he was alert and cooperative. There was a severe left lower facial weakness equally present in voluntary and associated movement; a left hemiparesis with maximum incidence in the arm, but no sensory disability, could still be demonstrated.

The patient was subsequently discharged, but re-admitted for review in October, 1945. A radiograph showed the metallic foreign body still in position but

lower and more anteriorly than previously. An air encephalogram showed enlargement of the right anterior horn and anterior part of the body of the ventricle, which bulged towards the side of the lesion. There was no gross ventricular shift.

On discharge he was distractable and restless, and his wife accused him of never being in. He was drinking much more than was his normal habit. A few months after his return to civilian life he was before the courts on two separate charges of indecent exposure. Since that time he has served several prison sentences in various parts of the country for similar offences and also for failing to maintain his wife. Apart from casual labouring jobs, he has been unemployed. His wife now refuses to have anything to do with him.

When interviewed in June, 1952 (H. F. J.), he gave the following account of himself: "I class myself as a dreamer; perhaps I am dead lazy. I can't seem to settle. I am drinking more and talking more. I have become a sort of 'know-all'."

He strongly denied any tendency to exhibitionistic practices before the wound. The incidents of indecent exposure often occurred after drinking and they were "invitations" to sexual relations; he was overcome with strong sex feeling which required relief. He stated that his sex feeling had increased since the wound; his wife told him that "sex was all you married me for" and complained of the roughness of his sexual approach, although she had made no such complaint in the early months of the marriage, which had taken place in 1943.

In spite of all this, he is fully aware of the fact that his conduct is reprehensible, and he blushed when relating the incidents of indecent exposure. He realizes that he has diminished control in sexual matters and has associated feelings of guilt and a sense of shame.

He gave the following account of his home background:

"My home was strict. I can truthfully say my father was the only man of whom I have ever been afraid. He was a man who laid down the time we should get up in the morning and the time we should go to bed at night. Sex was taboo. Although he took his drink, we were not allowed to drink. I only really started to drink in the Army. As a young man I was not over-keen on girls and was always uneasy in their presence. I had a cast in my left eye which made me shy of girls. Now my wife refuses to live or sleep with me and complains that I persistently wake her up during the night to have sexual intercourse. At home I would never interrupt a conversation; now I want to butt in."

It is recorded in his notes that "before injury he was a quiet but ambitious man who made a few firm friends rather than a lot easily."

The following account was obtained from his father:

"He is not the same man at all as he used to be before his injury, being then kind and obliging at all times. He was a boy who never gave his mother or myself any worry at any time. He had a kindly disposition and was as honest as the day. There is no doubt about it, he is a changed person since his knock on the head."

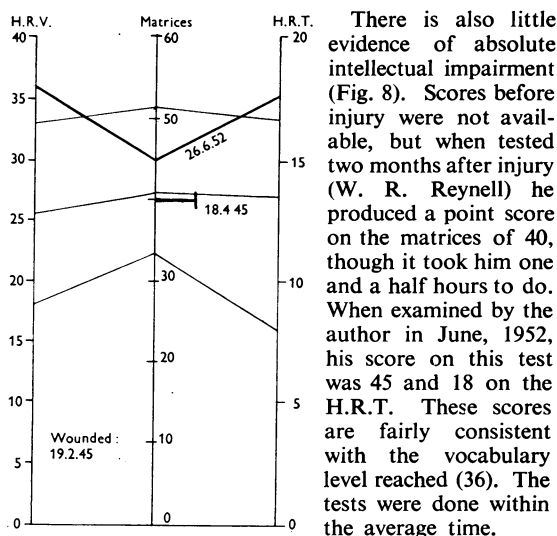


FIG. 8.—Mental test results in Case 3. No pre-traumatic scores were available in this case.

There is also little evidence of absolute intellectual impairment (Fig. 8). Scores before injury were not available, but when tested two months after injury (W. R. Reynell) he produced a point score on the matrices of 40, though it took him one and a half hours to do. When examined by the author in June, 1952, his score on this test was 45 and 18 on the H.R.T. These scores are fairly consistent with the vocabulary level reached (36). The tests were done within the average time.

As in the previous case, the patient's control over his sexual behaviour has decreased, leading not only to disturbed relations with his wife but also to anti-social acts and imprisonment. Again, in this case the rather overinhibited pattern may be seen in the picture of the patient's previous personality.

In the above three cases, although disinhibition appears to be most prominent in the sexual sphere, it has also been observed in other aspects of the patients' behaviour: they have all become more talkative, and this is a distinct alteration in the normal pattern which they showed before injury.

Disinhibition in Simple Social Relations.—In the three cases which will now be described there is no evidence that disinhibition has occurred in the patient's sexual life; it is shown mainly in his simple social relations.

Case 4 (M.R.C. No. 959).—This 23-year-old corporal was wounded in Korea by enemy shell fragments on April 24, 1951. The missile entered the left parietal area, passed through and through, leaving by the right frontal area (Fig. 9). On admission to a U.S. field hospital on April 25 he was stuporous, but could be roused. There was divergence of the eyes, dilatation of the left pupil, and left lower facial weakness, extensor rigidity of both legs, which he withdrew from pin-prick, and no movement in the left upper limb. Deep tendon reflexes were increased on the left side.

A radiograph of the skull revealed a fracture of the left occipito-parietal region, with indriven bone fragments; a cranial defect was also seen in the right frontal region.

At operation on April 25 (Lt.-Colonel Meirowsky)

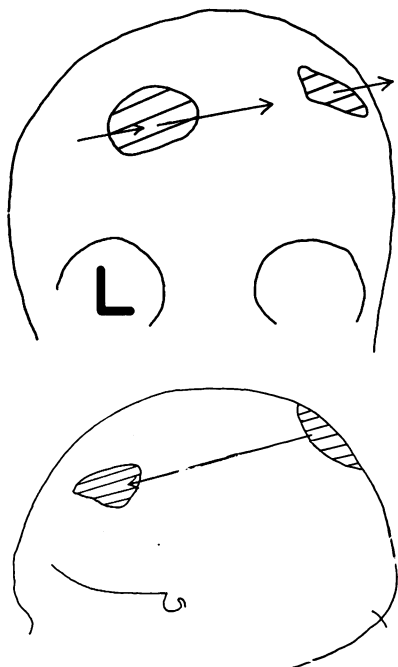


FIG. 9.—Tracings of skull radiographs in Case 4. Through-and-through wound: entry left parietal region, exit right frontal region.

left occipital and right frontal craniectomies were performed.

A moderate-sized bone defect was revealed in the left parieto-occipital region. Exposure of the dura revealed a moderate-sized dural tear from which liquefied brain was exuding. All liquefied brain tissue and a massive intracerebral haematoma were removed. Innumerable comminuted pieces of bone were encountered intracranially and removed. The track was followed to the falx, which was well visualized.

There was massive shattering of the right frontal bone where the dural tear was irregular and somewhat larger than that found at the site of the wound of entry. An enormous intracerebral haematoma was delivered. Following its evacuation a large amount of liquefied brain tissue presented itself and had to be removed by suction. A small number of comminuted bone fragments were encountered intracerebrally and were removed. Digital palpation revealed two tracks: one leading directly to the perforation in the falx, and the other to the right occipital lobe. The later apparently represented the cavity which had been occupied by the massive intracerebral haematoma. The post-operative course was uneventful and the patient gradually became more responsive.

On admission to the Military Hospital for Head Injuries on July 31, 1951, neurological examination revealed the presence of a left hemiplegia, with some facial weakness on the left side involving both upper and

lower muscle groups. The pupils were equal and reactive. There was a spastic weakness of the left upper limb. Tone and power were normal in the right upper limb. Tendon reflexes were markedly increased on the left, and sensation was normal. There was a spastic weakness of the left lower limb, with severe clonic spasm; the tone and power of the right lower limb were normal. There was a left extensor plantar response. He was subject to occasional focal sensory attacks affecting the right arm and leg, but no general convulsions. Visual fields showed no gross deficit but some spatial dis-orientation.

When examined in October, 1951 (H. F. J.), he gave a full account of his difficulties. He resented his helplessness and his dependence on other people for his simple physical needs. The last thing he remembered before the wound was the man next to him being shot and the enemy all around them (retrograde amnesia, a few minutes). He did not remember actually being hit. His first clear memory subsequently was of being in the American Hospital in Tokyo (post-traumatic amnesia, three weeks).

He complained of being depressed—"very miserable at times". "I resent advice on what to do. I get extremely irritable for no reason at all, unlike my usual self. I am a lot slower in thinking. Things take a long time to sink in. I get angry and want to strike people. Normally I am an easy sort of person; now I say things and regret them afterwards. The blank in my memory worries me: it is not very nice having a chunk out of one's life." When pressed for more information about this, he said, "Well, I wondered if the chap who fell down before I was wounded was really dead. He looked dead, but I was worried in case he was not and I should have done something."

His condition remained the same for about six months, when he gradually became more settled and brighter, undoubtedly helped by his increased physical self-dependence as his rehabilitation proceeded. During this six months he was depressed, self-pitying and irritable; he slept poorly at nights with recurrent terror dreams. Although sorry after the irritable outbursts, he resented apologizing, as he felt it was not his fault. He fully realized that his behaviour was quite unlike what it normally would be.

"I never had a schoolboy fight. I would walk away rather than get into an argument with anyone." He wondered if the wound were a punishment for past wickedness on his part, and thinks he will soon have no friends, as everyone finds him difficult to deal with. He created a scene by telling one of his severely disabled comrades to go out and get a job, as he was only hanging on in hospital to get his full pension. (He seemed unable to appreciate how tactless this remark was.)

He gave the following account of his personality and home background:

"I was reserved and shy before. My home was regimented, but not grossly strict. Father was a regular soldier. Normally I would confide in mother rather than father. I wouldn't say boo to a goose. I was not interested in games until I came into the Army. I was

afraid of father, perhaps jealous of him. Perhaps he was jealous of me. I was always shy of him. Before my wound I would hardly have said more than 'yes' or 'no'; now I talk a great deal more. I can't assimilate things in the same way; I am not so mentally active. I cannot do crossword puzzles as I used to. I can't do anagrams. I am now talkative and there is a fiendish element in it; I say hurtful things."

He showed no loss of initiative, and, indeed, as he became more settled a great deal of driving force was apparent. On the whole this was well coordinated and showed little of the distractibility associated with other types of frontal lobe "restlessness". It was all directed towards his rehabilitation, obtaining a house for his mother and himself, and in making plans for his resettlement. He described an interesting feature of his pre-wounding personality which showed the strength of purpose and drive which lay beneath the apparently quiet exterior. "I was always a go-getter and would go to any length to get my own way provided it did not mean doing a dirty deed, even at the expense of losing my friends."

The following account was given by his mother:

"He has changed since his injury; those fits of temper have worried me a great deal. You see, my son was the nicest boy, and so even-tempered before: a sweet, placid boy who could get on with anyone. He did not go in for rough stuff, but would talk his way out of an argument. He had a rather reserved nature, but was always well liked. He is not himself—he now rows with people and is cross with them. He flies into a temper and swears at his younger brother. He practically brought my young son up and was most considerate to him. Now he seems to have turned against him. He is very distrustful of everyone and does not seem to be able to consider the feelings of other people."

In spite of the improvement in his general outlook, he continued to have tactless outbursts in which he was unable to control his feelings and in which he expressed his opinions forcibly. He regretted these outbursts and would apologize for them later. He was fully aware of the change in his personality—"I know it must be difficult for you to believe that I used to be such a quiet little boy. Now I have more self-confidence and can talk to anyone."

The following information was obtained from the report of the personnel selection officer who dealt with him on Army entry (1947): "Above average education and intelligence. Has leadership qualities. Not too responsive, but should develop alertness with further training."

In this case the intelligence testing reveals a severe and absolute intellectual loss (Fig. 10). It is significant that he failed on all three conceptual tests at the same level, whether such tests involved visual patterns (matrices) or the manipulation of verbal material (H.R.T.). He was unable to see through the more complex relationships and solve the more difficult problems. In all tests he tried very hard, and his disappointment and frustration were very obvious when he realized his ability to perform these tests was much below his own expectation.

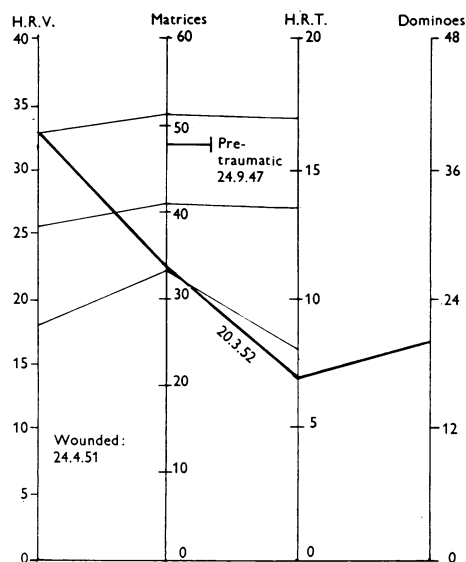


FIG. 10.—Mental test results in Case 4, showing marked failure on each conceptual test occurring at approximately the same level. Scores much below that expected for the vocabulary level reached.

This contrasted with the rapidity with which he was able to do the vocabulary test, producing a score of 33. This difficulty in conceptualization was noted in the clinical history, as he had himself observed that he was no longer able to do the anagrams in crossword puzzles. His score on the matrices (34) was well below that which he had produced on Army entry four and a half years previously (48).

In spite of this substantial decrease in his ability to conceptualize, his ability to read and to use verbal material was quite intact. He was able to give a full and complete account in words of anything that he might wish to communicate, with no apparent defect. Indeed, his descriptive powers were excellent and had a graphic quality: when describing his experiences in Korea, he spoke of "the plasticine figures lying wounded on the battle-field, with their heads turned to one side, and not being able to get at them, as the ground was strafed with machine-gun fire".

In this case the disinhibition has manifested itself mainly in talkativeness and in tactlessness. The patient himself is aware of the change.

The pre-wounding personality is confirmed by his mother's account.

In a through-and-through wound of this nature it is not possible on the evidence presented by this single case to draw any conclusion as to the anatomical basis for his diminished conceptual ability; it need not necessarily or solely depend, therefore, upon the frontal lobe involvement.

Case 5 (M.R.C. No. 965).—This 24-year-old corporal in the Royal Marines was wounded on November 1, 1944, while serving in a L.C.G. A shell hit the turret and he received a severe injury to the forehead. He was knocked unconscious and was still unconscious on admission to hospital next day. There was a large linear scar down the centre of the forehead, with comminution of bone and gross cerebral trauma. By November 3 he was able to answer his name, while by November 8 he was conscious and accessible, but quite disorientated. At an operation performed on November 9 a good deal of bone and necrotic frontal lobe was removed on each side, leaving cavities in the brain about the size of walnuts (Fig. 11).

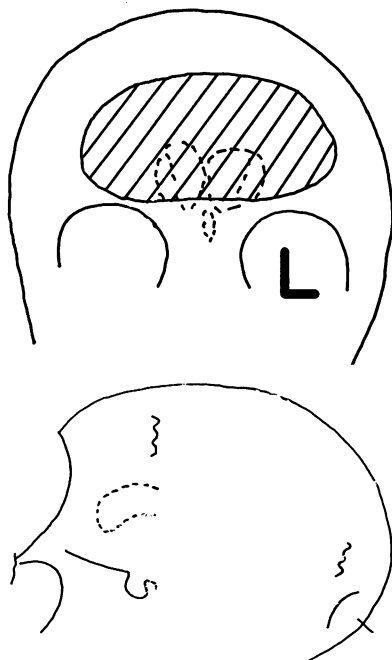


FIG. 11.—Tracings of air encephalograms in Case 5. There was bilateral destruction of frontal poles with slight ventricular dilatation.

He was admitted to a Royal Naval neuropsychiatric hospital in January, 1945, when physical examination showed no abnormalities except bilateral anosmia and a slight enlargement of the right pupil.

A psychiatric examination was reported on as follows :

“His powers of deduction from a story were bad, and he had considerable difficulty in grasping abstract situations. Temperamentally, he felt better and had lost his normal tendencies to irritability and slight explosiveness. This change of character in the direction of placidity was confirmed by his mother and his ship-mates.”

The position was rather different when a home visit was paid in May, 1945. His mother reported that he was

no longer quiet and amenable as he had been on his return home. He was now bad-tempered, irritable, and frightening in his aggressiveness.

When interviewed (H. F. J.) in July, 1952, he gave the following account of how he now found himself : His memory was bad for recent events, and he had difficulty in concentration. He has been unable to settle in employment and has had 18 jobs since 1945. He has not the same “go” as he used to have and sits at home for hours, playing patience. He used to like to drink, but can’t take the amount he used to—“no interest in the stuff”. He has a worried, perplexed expression ; sleeps well, but his appetite is poorer.

It was noticed that when he was asked for any information he would always elaborate the answer by adding exact dates—e.g., “Is your grandmother alive?” “No, 12th June, 1950.”

Other obsessional symptoms, especially counting rituals, were soon revealed. He would add up the vehicle numbers of cars in the street to see if the answer came to 13, also the ward numbers as he walked round the hospital. If they did, he felt a sense of satisfaction ; if they did not, he was disappointed. It was difficult to get a clear picture of whether these obsessional symptoms were new or had only become more prominent since the injury. There was some evidence that they were not entirely new, as he had noted that his service number added up to 13 and he thought he was aware of this before injury. During the interview he was polite and informative. He admitted to being very irritable at times, losing his temper, and on occasions smashing some articles at home.

Apart from this, there was little evidence of gross disinhibition. It was noted, however, that during the interview he volunteered information about his personal life a little more freely than one normally expects a patient to do when being examined for the first time. He told spontaneously how he had acquired a venereal infection before the war, and described without being specifically asked how the girl whom he had intended marrying had become pregnant by another man and had thrown him over in the early stages of his injury. He even volunteered her full name and address. He emphasized his loss of interest in women. At the end of the interview, while remaining polite and even deferential, he was asked if there was any other information he could give which would be of help in assessing his case. He rose, paused for a moment, and then said reflectively, “No, sir. No, sir, I don’t think there is, thank you very much. But”, raising his forefinger and waving it waggishly at the examiner, “but remember, behave yourself.”

His father deserted his mother when the patient was 4. He was a violent man and drank to excess. A younger brother suffers from “periods of paralysis”. The patient was at school until the age of 14 and reached the top form. He was better than average, good at games, and a good mixer. He worked as a farm labourer until he joined the Marines at the age of 17. He had been in trouble in the service on one or two occasions, usually because of absence without leave after a bout of drinking.

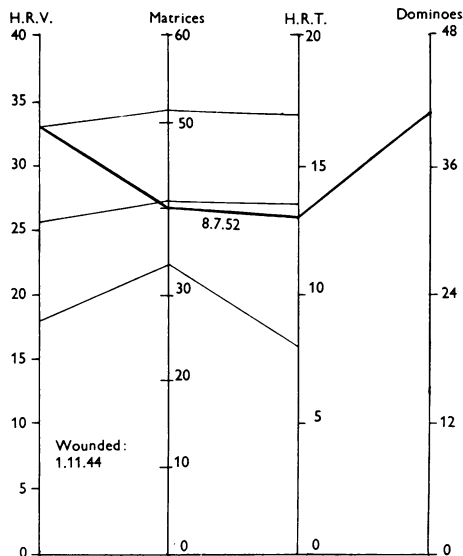


FIG. 12.—Mental test results in Case 5. No pre-traumatic scores were available in this case.

Apart from the foregoing, an adequate picture of his previous personality could not be obtained.

The results of the intelligence tests are of interest (Fig. 12). His scores on both the matrices (40) and the H.R.T. (13) are rather low for the vocabulary level reached (33). When he did the Army dominoes, however, he produced a high score (41). It is perhaps significant that this test involves a calculating element which is not present in the matrices. In view of his tendency to obsessional counting, it is probable that he did much better in this test because of this. In this case there would appear to be no evidence of intellectual impairment.

In this case disinhibition was not immediately obvious. There were no attacks of tactlessness which are upsetting to all around, no disturbance in the control of sexual behaviour, merely a tendency to be rather more forward in his personal relations and to express himself rather more freely than one suspects he normally would. Irritability and explosiveness were a feature of his personality before wounding, although they had increased in intensity since injury. There is, however, a marked loss of drive and initiative, and he showed the simple and emotionally flat approach to his problems characteristic of certain types of frontal lobe loss.

Case 6 (M.R.C. No. 973).—This 19-year-old private was wounded in Korea on November 19, 1951, sustaining a penetrating wound of the left frontal region (Fig. 13). He was admitted to an American neurosurgical field unit within three and a half hours of being found wounded. He was then stuporous, but fairly rational. There was a 4 cm. stellate laceration in the left frontal

region anterior to the hairline, and through this defect cerebral herniation was present. At frontal craniectomy the scalp laceration was debrided and the craniectomy extended into the left frontal sinus. Many embedded bone fragments and liquefied cerebral tissue were removed. The post-operative course was uneventful, but radiographs revealed four retained intracranial bone fragments at a depth of approximately 7 cm. as measured from the anterior left frontal bone. A second left frontal craniectomy was performed on November 25, and the retained bone fragments were removed (Lt. Col. Meirowsky). His course after this was uneventful.

On admission to the Tokyo Army Hospital on December 8, 1951, he was alert, rational, and well orientated. Cranial nerves were intact, fundi normal, and there was no facial weakness. There was good strength in the upper and lower limbs, and sensation was intact. Deep tendon reflexes were equal and active.

On admission to the Military Hospital for Head Injuries in January, 1952, he had no complaints and was fully orientated. Retrograde amnesia was a few seconds, post-traumatic amnesia three days. There was no neurological deficit on examination, and an air encephalogram was normal.

When examined in September, 1952 (H. F. J.) he was mildly euphoric. He said he felt quite normal, but that other people had remarked on his "high spirits", especially his friends.

Before the injury he was rather shy and easily embarrassed, especially with girls, with whom he found it

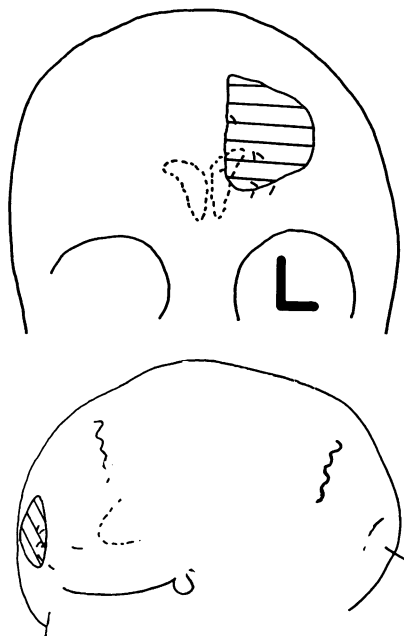


FIG. 13.—Tracings of air encephalograms in Case 6 showing penetration into left frontal lobe only. No ventricular deformity.

hard to make friends. When he approached girls he would become tongue-tied and feel worked up inside, but now he was "as good as the next man". When the men at work pulled his leg he would "blush and that sort of thing" and "keep his mouth shut rather than answer back". He felt that he was more shy than the average boy. He had quite a few friends, but did not make them easily and had to get to know them well first. He was rather self-conscious, yet when he was with a gang of boys he was always the ringleader in escapades; when approached by an older person, however, he would dry up and be unable to speak. He was especially shy of talking to older people.

After injury, when he returned to his old job as a house-painter (which he has held since leaving school), he shocked his old foreman by answering back—an unheard-of thing before his injury. Now he is devil-may-care and has done one or two foolhardy things like jumping off a bridge into a river and trying to ride his bike along the bridge wall.

His mother tells him he is no longer serious but "flippant". In spite of the rather inhibited aspects of his pre-wounding personality, in his schooldays he was not afraid to fight. Now he feels more placid.

It has so far been impossible to get a good objective account from this man's relations about the personality change. The following is all that could be obtained from his father:

"He was quite healthy before his wound and used to do amateur wrestling at the lads' club, but I have noticed since he came back that at times he acts rather foolishly. I put it down to nerves or worry. He has worked regularly since he started, but has complained of headaches sometimes, otherwise he seems all right."

On intelligence testing (Fig. 14) he produced a basic

score of 43 on the matrices. His performance, however, was erratic, and he showed a rapid, careless approach when doing the test. This is to some extent revealed in his sub-test scores (i.e., his individual scores on sets A, B, C, D, E of the matrices) which were 12, 7, 10, 8, 6 (43). He was given an opportunity to correct this score, and his corrected score was 52 (12, 12, 11, 10, 7). On the H.R.T. he produced a score of 18, and on the Army dominoes a score of 37. These scores are consistent with the corrected score on the matrices and with the vocabulary level reached (27). The vocabulary level is perhaps a little lower than might have been expected from his performance on the conceptual tests, but is not inconsistent with his cultural background. His pre-traumatic score on the Army dominoes at Army entry two years previously was 34. There is therefore no evidence of intellectual impairment in this man's case.

In this case the patient has become mildly disinhibited. He is fully aware of the change in the normal pattern of his behaviour, and this change has been noted by his parents. There is also some evidence that the tendencies which appear on disinhibition in his case were present beneath the surface in his pre-wounding personality.

Analysis of Case Material

Personality and Disinhibition.—In these case records great care has been taken to assemble available information as to both the pre-traumatic personality and the nature of the post-traumatic disorder of behaviour. From this it has become apparent not only that there was evidence of over-inhibition before wounding in these cases, but that there were present in the pre-wounding personality tendencies which appear frankly in the disinhibited behaviour after injury.

Case 1 was externally modest and prudish, not interested in sex, while in fact reading books of a sexual type and indulging in intermittent physical sex activity. His pre-injury conflict about sexual matters appears in his talk protesting about sex activity, while the remnants of the inhibiting process can still be seen in his violent reaction to any simple expression of normal sex activity.

Case 2 had a temper which he could control before injury, was probably always sexually demanding, and had feelings of inferiority. He is now garrulous where he had been quiet, boastful where he had been modest. His mother regards the talk and boasting as a cover for the feeling of inferiority which she maintains still lies behind it all. The remnants of the inhibiting process can be seen in his case also, as he still becomes panic-stricken when faced with anyone in authority.

Case 4, who "wouldn't say boo to a goose", would nevertheless get his own way even at the

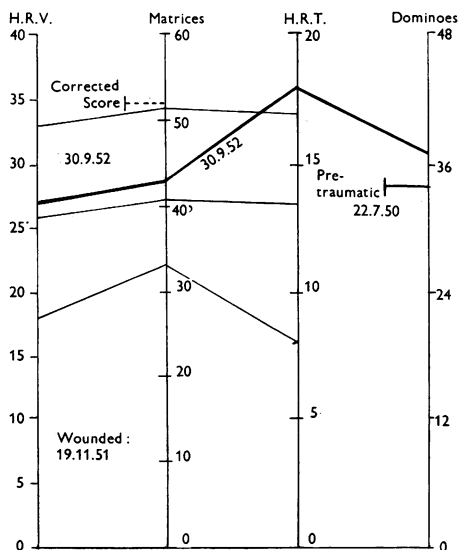


FIG. 14.—Mental test results in Case 6.

expense of losing his friends. He is now tactless and shows a considerable driving force in his new temperament.

Case 6, beneath the inhibited personality, was a ringleader of a gang of boys, a feature well related to his foolhardy escapades since injury.

The evidence presented by these cases therefore suggests that where disinhibition occurs after frontal lobe damage it appears in those aspects of the personality where continued inhibition was necessary before injury.

Awareness of Change : Insight.—In all but one of these cases (Case 5) the patients were fully aware of the change in the personality due to disinhibition and were able to describe the alterations which had taken place. There is thus insight into the disinhibition, but in spite of this these patients are on the whole unable to exert adequate control over the new behaviour. Case 1 would not begin his sex talk immediately with strangers, but the latent period before he did so was very short. Case 3, even after several prison sentences for indecent exposure, was reported to be exposing himself again within a few days of his discharge from prison. Nevertheless, although he strongly wished to do so, he refrained from exposing himself when being interviewed by a female member of the staff.

Initiative and Spontaneity : Other Changes.—It can be clearly seen from these cases that disinhibition is quite separate from the other disturbances of function which have been described as part of the frontal lobe syndrome. Thus, loss of initiative was only a feature in four of these six cases, and in these four its intensity varied.

The social incompetence which is sometimes a feature of frontal lobe damage would seem to be due to a variable admixture of factors and not solely to be dependent on the overall reduction of emotional drive which is presumably the cause of the loss of initiative. Thus, distractibility, restlessness, and the domination of the patient's personality by the new adverse behaviour (as in Cases 1 and 3) all play their part in making directed activity impossible or difficult.

A severe disturbance of spontaneity is a feature of the early stages of frontal lobe wounding in certain cases, and in this series it is most strikingly shown in Case 2. The period of disturbance in the early stages of severe frontal lobe damage may be very prolonged, consequently much of this lost spontaneity is recoverable, although it may be several months before the patient attains his new basic level.

Affective Changes.—Whatever may be the role of the frontal lobes in the control and development of the emotions, the appearance of disinhibition does not mean that all varieties of affective experience are abolished.

Of these six cases, perhaps only Case 1 showed a substantial loss of feeling. It was almost impossible to make him angry, and, as his father said, "He has no resentment about his injury. No feelings about war. No feelings at all, I don't think". In his case there were no episodes of irritability, no outbursts of temper or violence. Outbursts of anger were a feature of Cases 2, 4, and 5. Case 3 was ashamed and blushed when recounting his sexual delinquencies. Case 4 was depressed for several months after injury, afflicted with feelings of guilt, and wondered whether his wound was a punishment for past sins. Case 5 was subject to well organized ritual obsessions. The development of excessive orderliness after brain injury has been described by Goldstein (1942), but there was some evidence of obsessional behaviour before wounding in this case. Case 6 was mildly euphoric.

Intellectual Changes.—In five of these six cases the wounds, to all intents and purposes, were restricted to the frontal lobes, although in Case 3 a metal fragment had entered the anterior parietal region. With the exception of Case 1, no intellectual impairment, in the sense in which it has been carefully defined in the early part of this paper, could be demonstrated even when the frontal lobe destruction was extensive, as in Case 2. No definite opinion could be given about Case 1, although some impairment is probable.

Case 4, in which there was a through-and-through wound causing much destruction in the left parietal and right fronto-parietal region, showed a severe and unequivocal loss in conceptual ability. The exact part played by the destruction of frontal lobe tissue in producing this deficit cannot of course be established on the basis of this single case alone. The case is of interest, however, in its own right, as it shows that a considerable loss of abstract and relational thinking may occur with the complete preservation of everything pertaining to the understanding and use of verbal symbolism.

Anatomical Deductions.—In spite of the excellent radiological and surgical evidence available, it is not possible to be dogmatic about the exact site and extent of the lesion in each case. Nevertheless, there is evidence that three of these wounds were unilateral only—namely, in Cases 1, 4, and 6. In Cases 1 and 4 the left frontal lobes were probably

left intact, while in Case 6, although the injury was near the midline, the right frontal lobe was probably undamaged. No relation between the appearance of disinhibition and any particular site within the frontal lobes can be established in these cases; in every case, however, the wound penetrated deeply into at least one frontal lobe.

Cerebral Dominance.—No association could be found with handedness and cerebral dominance: all six patients were right-handed.

Traumatic Epilepsy.—Attacks of traumatic epilepsy occurred in Cases 2 and 4 only. They were reported to have begun in the early weeks after injury. In the other four cases no attacks have been reported. Traumatic epilepsy is certainly not a prominent feature of these six cases. Fits were reported in Cases 2 and 4, but in Case 2 only occurred early in association with intracranial infection, and in Case 4, where the parietal lobes were severely involved, only minor focal sensory attacks occurred.

Post-traumatic Amnesia.—In the study of closed head injury Russell (1932) emphasized that a convenient method of classifying the severity of the injury is by assessing the duration of the post-traumatic amnesia. In four of these six cases in which the post-traumatic amnesia had been estimated, it varied in duration from 36 hours to three weeks (Cases 2, 3, 4, 6). In the other two cases it had not been accurately measured, but the patient was reported to have been conscious, rational, but disorientated in time in the one case at the end of seven days, and in the other at the end of nine. Full orientation was not noted in the records until four and six weeks after injury respectively.

The significance of a long post-traumatic amnesia in penetrating brain wounds, where the maximum damage is more localized than in closed head injuries, is not clear. Whether it indicates more extensive and more remote trauma than would be implied by the purely local injury due to concussive effects, or is due to damage to specific (e.g., diencephalic) mechanisms concerned with consciousness, is a matter of conjecture. It can only be said that as far as these cases are concerned disinhibition occurred whether the post-traumatic amnesia was short or long, and that residual intellectual impairment could not be demonstrated even when there was evidence of a prolonged disturbance of orientation after injury.

It seems reasonable to assume, therefore, that the disinhibition which has occurred in these cases is due to the main injury causing interference with

mechanisms which have their locale within the frontal lobes and is not due to coincident or associated involvement of other parts of the brain. It can only be added from the experience of the other wounds personally studied so far, of which this short series forms a part, that disinhibition has not been noted unless the frontal lobes have been involved.

Discussion

The study of these six cases provides evidence towards the understanding of the phenomenon of disinhibition as it appears after frontal lobe damage.

Disinhibition results in a permanent alteration in the temperament of the individual, in which the control of behaviour in its social aspects is reduced. It appears immediately after injury, but may be masked in the early stages by other disturbances of function, such as loss of initiative and spontaneity, confusion, and disorientation. It may be unassociated with other features which have been described as part of the frontal lobe syndrome; it may occur without loss of initiative, without intellectual impairment. It can be present with a variety of affective experience. Moreover, the patient is generally aware of the change in his personality caused by the appearance of the disinhibition and can describe the differences between his previous and present attitudes and tendencies. There is thus insight into the new pattern of behaviour but control over it is minimal or negligible.

All these points are fully illustrated by the cases described above.

Disinhibition adds nothing new to the personality: it merely alters the external relation of the personality to the environment and reveals tendencies which were present before injury but which were previously permitted only limited expression. This would appear to be a reasonable conclusion to draw from the personality studies presented in this paper.

It is significant that in these cases there is no regression to grossly primitive or infantile behaviour. Presumably, in mental development certain aspects of behaviour become so controlled that their continued inhibition is no longer required, and it is those aspects of behaviour in the above cases, where continued inhibition before injury appeared to be necessary, which become most prominent after wounding. This apparent specific relation between the previous personality and the features which appear after wounding offers an explanation why disinhibition is significantly observed only in certain cases and, when it does occur, involves different aspects of the personality in different people.

What are the anatomical conditions under which disinhibition appears? There seems to be good evidence from this material that involvement of only one frontal lobe is necessary. This confirms the similar conclusions of Rylander (1939), based on lobectomy material, that the removal of either the right or the left frontal lobe was equipotential in its effects.

In the cases described in this paper no relation could be seen between the appearance of the disinhibition and any particular site within the frontal lobes. There appears, therefore, to be no obvious topographical correlate of the disinhibition. The missile had penetrated deeply into at least one frontal lobe, although there were obvious differences in the amount of cerebral tissue destroyed. In this regard attention is drawn to Case 8 of the Columbia-Greystone Associates (Mettler, 1949), in which gross deterioration in social behaviour due to disinhibition occurred after a bilateral ablation of frontal cortex, mainly of the middle frontal gyri, in which a total of 16.5 g. of tissue was removed. This deterioration was attributed to the removal of too much tissue. Before operation this patient had, however, a well preserved personality, his illness being one of hypochondriasis with somatic delusions accompanied by considerable affect. After operation he became carefree, garrulous and outgoing, less conscientious in his work, and insulting in his behaviour. This insulting behaviour was noted especially towards his sister (a nun) for whom he had previously had great respect. While the details given of his background are inadequate to form a conclusion, certain similarities can perhaps be seen between his personality before operation and that of the cases described above.

It would seem to be true also that even after extensive excision of the frontal lobes, as in lobectomy, the degree of disinhibition may be so slight, if it occurs at all, as to escape ordinary clinical assessment (Jefferson, 1937; Hebb and Penfield, 1940).

There appears therefore to be no direct and constant relationship between the amount of frontal lobe tissue destroyed and the appearance of disinhibition. In all these cases the loss of brain substance has been severe, but the evidence presented in this paper suggests that for such a loss to be effective in producing overt disinhibition it has to occur in people of a certain type of personality.

While it is true that the organism lives in a milieu in which socially undesirable patterns of reaction are being constantly inhibited and substituted by socially more appropriate ones, it is

also true that the organism brings to bear upon the environment its own positive and definitive patterns of behaviour which are the result of the conditions existing within the organism itself and which in human behaviour are determined by the construction of the personality. The development of the personality, however, is such that when it reaches its completion in early adult life some socially undesirable tendencies may persist, so that social control can only be achieved by their continual inhibition. It is these tendencies which seem to come principally to the surface after frontal lobe injury. The mechanisms which come into play between the arousal of a desired but socially inappropriate train of behaviour and its expression or inhibition must be highly complex, involving the integration of different parts of the nervous system, and any attempt to explain them satisfactorily must be premature in the present state of our knowledge. Nevertheless, some understanding of the factors involved may be obtained from the evidence presented by these cases.

It can be seen that the inhibitory mechanism, even in its relation to the special aspects of the personality in which disinhibition appears, is not completely destroyed; inhibition comes into action but fails to be sustained (Case 1) or, although the threshold of inhibition is lowered in regard to a specific pattern of behaviour, inhibition is still capable of acting in certain circumstances (Case 3). It might be concluded, therefore, that the breakdown in the control of behaviour after frontal lobe injury is due less to the destruction of the actual inhibitory process than to a failure to decide what appropriate behaviour pattern should be assumed after the initial inhibition has taken place.

Brickner (1939) regards the control of behaviour as dependent upon planning which involves making certain emotional sacrifices to achieve certain emotional compensations, the formulation of concepts necessary to a planned course of conduct being based upon a capacity to make complicated intellectual syntheses. The behavioural disturbance after frontal lobe injury is due to a loss in the power to synthesize simple thought processes into more complex structures and is thus secondary to a kind of intellectual defect. This view of Brickner's must be critically assessed.

In the first place, it extends beyond its legitimate bounds the generally accepted interpretation of the words "intellectual" and "intelligence". Secondly, as is shown in the cases described above, the ability to make intellectual syntheses and form concepts is not lost even when there is evidence of diminished restraint in the control of behaviour. It would have

to be assumed, therefore, that the intellectual syntheses implied by Brickner were of a different character from those involved in normal conceptual processes.

The breakdown in the control of behaviour due to disinhibition after frontal lobe injury would hardly seem to be dependent, therefore, upon a disturbance of intellectual processes in the generally accepted sense. It is the facilitation of the undesirable pattern of reaction which is the essential feature, the necessary inhibition failing to be sustained long enough to allow an alternative and socially more appropriate behaviour pattern to take its place.

Inhibition in its ultimate analysis is concerned with the prevention of motor behaviour either of speech or action which at a given moment would be socially undesirable. Such inhibitory processes are not however rigid or fixed, and they are capable of being released or more strongly applied as the organism becomes aware of different factors in the environment. The organism is thus involved in a continuous process of adaptive scanning in which tendencies to impulsive behaviour, arising in relation to changing factors in the environment, are being continually inhibited. The inhibitory processes come into play so quickly that they can hardly be regarded as the result of conscious deliberation, although they produce the necessary brake on impulsive action permitting the organism to decide whether the intended behaviour may be allowed total or partial expression, or none at all.

It might not be unreasonable to conclude that in so far as the frontal lobes are concerned with inhibition they are concerned with the actual restraint of patterns of behaviour which are being activated from other levels of the nervous system.

In this paper one aspect of the problem of frontal lobe function has been dealt with; it must be obvious, however, from the study of the above six cases that many complex problems remain. Their solution can only come from an intimate study of the separate disturbances of function as they appear in different cases of frontal lobe injury and in avoiding any attempt to explain these disturbances prematurely in terms of unitary theories. Differentiation of function is always possible within the frontal lobes, and even though apparently diverse disturbances of function may be more closely linked than seems likely at present it is important that at this stage the deficits which appear after injury should be clearly studied and described in terms which can be understood by other workers in the field. It is only by clearly defining the deficits which we are investigating, and demonstrating their presence or absence in cases of frontal lobe

injury, while studying the conditions under which they arise, that it will be possible to understand better the part played by the frontal lobes in the control and organization of human behaviour.

Summary

Six cases of penetrating brain wound are described in which disinhibition appeared after involvement of the frontal lobes. It has been shown that disinhibition is a separate disturbance of function which need not necessarily be associated with other disturbances described as part of the frontal lobe syndrome. In most cases the patients are aware of the change in their personality due to the disinhibition, but can only exert minimal control over the new behaviour pattern.

Disinhibition can appear when only one frontal lobe is involved, without any obvious anatomical correlation with any special site within the pre-frontal area, though, as has been pointed out, the extent of frontal lobe injury was severe in all these cases.

Disinhibition can coexist with a variety of affective experience and can occur without any associated intellectual impairment. Much destruction of frontal lobe tissue appears to be possible without producing intellectual loss in the conceptual sense.

The relation between the appearance of disinhibition and the pre-traumatic personality is described in full, and reasons are given to explain why disinhibition only occurs significantly in certain cases and involves different aspects of the personality in different people.

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